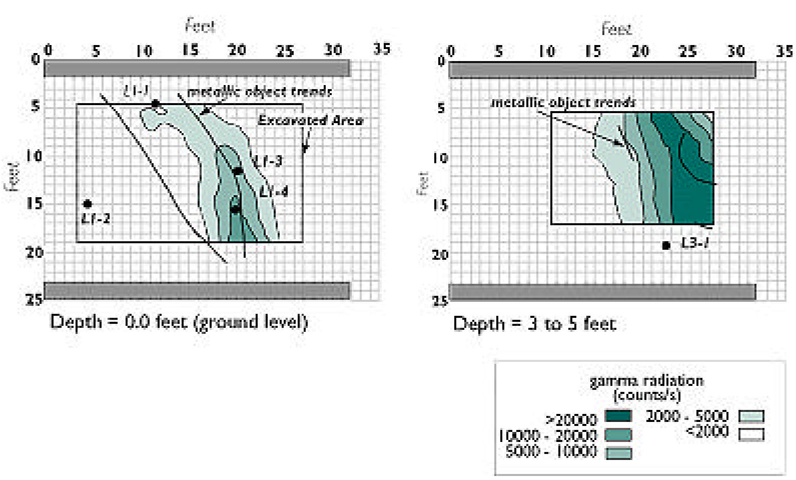
Initiatives ***first reported on dig-face characterization in the [June 1995] issue. Since then, the [Idaho National Engineering Laboratory] team has taken this technology through a successful field demonstration at the [U.S. Department of Energy's] Mound Site in Ohio. As a result of the demonstration, the team is adapting the technology for greater flexibility in the field. The new configuration is called "Warthog."***

Dig-face characterization may very well revolutionize hazardous waste retrieval from landfills and other excavation sites. By providing real-time, three-dimensional contour maps of the location and distribution of underground contaminants, dig-face characterization allows site personnel to modify excavation plans during digs to maximize worker safety and minimize mixing of contaminated and uncontaminated soils.

The dig-face characterization system consists of on-site, remotely operated sensors, which scan hazardous excavation sites for changing chemical, radiological, and physical conditions in the subsurface. Sensors relay data to a control station through radio frequency links. Data are analyzed on site to allow site managers to adjust excavation plans and inform workers of hazards that will be encountered in each successive layer of soil removed.



Dig-face characterization holds some crucial advantages over current sampling and monitoring methods. Remote operation avoids sending personnel into contaminated pits either to collect samples or to operate handheld sensors. The mechanical nature of the apparatus provides more thorough data collection, greater accuracy, and immediate results. In addition, the reliability of current sampling methods depends upon the locations and number of the samples--at hundreds of dollars per sample--and assumes that each sample is representative of its location. In contrast, dig-face technology performs in situ, bulk measurements of relatively large soil volumes, thus avoiding biases caused by small-scale heterogeneity in the contaminant plume.

During the August 1995 Mound demonstration, the dig-face sensors were mounted on a trolley, which limited the scanned area to about 20 by 30 feet by 5 feet deep. Nick Josten, Lockheed Martin Idaho Technologies' principal investigator for INEL and initial concept designer, said the system they are working on now will have much greater deployment flexibility. "We do not want to limit the size of the excavation site. Now that we have shown how valuable dig-face measurements can be, we have developed a very lightweight, mobile system capable of taking measurements under nearly any conditions." The new configuration will allow scanning of areas 100 feet or more in length and width.

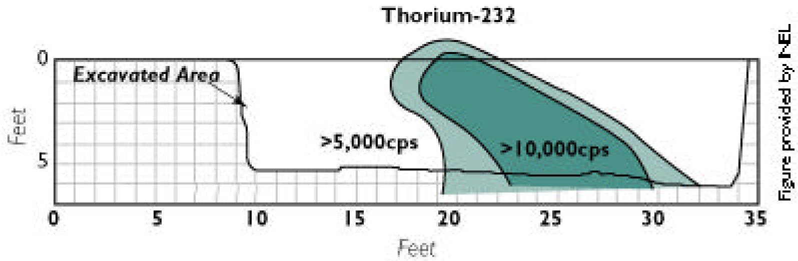
Nicknamed "Warthog," the new dig-face characterization configuration will also be more portable and easier to use. Josten estimates that the Warthog will weigh about 200 pounds and fit in the back of a pickup truck. The Warthog instrumentation will adjust itself to an accurate height, keeping the sensors at a constant height of 12 inches above ground, even with the typically diverse terrain often encountered at dig sites.

Three sensors were used at the Mound Site:

- gamma/neutron mapper (GNM), which provides high-sensitivity detection of gamma fields at high speeds;
- germanium gamma-ray spectrometer, or Ge-spectrometer, which identifies the specific radionuclides associated with high-gamma fields measured by the GNM; and
- magnetometer/laser rangefinder (MLR), a dual-purpose sensor used to detect buried metallic debris and to map dig-face topography.

Josten explained that the Warthog will not be limited to these three sensors. "We've designed the system to incorporate enough different sensors so that we can integrate a new sensor within a couple of days." Depending on which sensors are attached, dig-face characterization could be used not only for waste cleanup, but also for mining, unexploded ordnance removal, and archeological digs--essentially any application requiring high-quality sensor measurements under hazardous conditions.

Measurements at Mound were taken at four successive excavation depths. (Two of the four are shown on page 12.) When combined into a single data set, the four levels of collected data produced a three-dimensional image of contaminant plumes, as shown in the figure above. By combining sensor data, the system identified and clearly delineated a narrow seam of thorium-232 and a separate actinium-227 plume. Investigators also employed conventional Sampling and Analysis Plan procedures, successfully confirming the dig-face scanning methods.



This contour map is a side-view of the thorium-232 contaminant plume at Mound.

Guided by these high-resolution contaminant maps, site managers can conceivably excavate clean and contaminated soils separately. Every box (3.4 cubic yards) of soil returned to the excavation site saves $5,000 in long-term storage and disposal costs. By this method, 162 of the 191 boxes excavated during the Mound test could have been returned to the site, for a total savings of around $800,000. However, this will require additional regulatory approval. Kathy Lee Fox of the U.S. Environmental Protection Agency's Region 9 visited the Mound demonstration last summer; she saw dig-face as a step toward improving sampling methods and improving worker safety and waste minimization.

Once INEL completes the new Warthog configuration, the dig-face technology will be ready for its first major customer, the site managers in charge of environmental restoration at Sandia National Laboratories. Due to the technology's success at Mound, several contractors have expressed interest in commercializing this OST technology, which was funded through the subsurface contaminants focus area. Commercialization efforts will begin once the technology has been reconfigured into the lighter, more flexible system.

Josten expressed gratitude for those who have made the proof-of-concept possible. "This whole system has been four years in coming. DOE has been very patient. Mound staff also deserve enormous credit for meeting a ton of demands. They gave us the chance to show [dig-face characterization's] potential in a highly controlled dig area."